Surgery for Resection of Seizure Focus – General Anesthesia or Conscious Sedation

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OBJECTIVES

Understand the major types of epilepsy, diagnostic workup, and rationale for surgical treatment.
Develop an anesthetic plan compatible with intraoperative electrocorticography, brain mapping, or awake resection of seizure focus.
Discuss the pharmacology of anesthetic drugs used in seizure surgery and their effect on electroencephalogram.
Anticipate and manage intraoperative complications in the patient undergoing awake craniotomy.

STEM CASE - KEY QUESTIONS

A 12 year old girl with the history of intractable seizures was admitted to the hospital for diagnostic evaluation and for the possible resection of seizure focus. MRI revealed abnormal pathoanatomy of the left hyppocampal formation. Noninvasive EEG monitoring captured a partial seizures arising from the left frontal-temporal region. Wada test was consistent with the left hemisphere language dominance.

Discuss classification of seizures, major types of epilepsy, and surgical versus medical treatments

What is the Wada test?

What is significance of left hemisphere dominance?

Discuss anesthesia for the diagnostic procedures.

Because of the proximity of the seizure focus to the eloquent area of the cortex, the epileptologist suggested two-stage procedure. General anesthesia was used for the first stage operation that included craniotomy and placement of subdural electrodes for the invasive electrocorticography and awake cortical stimulation.

How localization of the epileptogenic zone is performed?

What is electrocorticography?

What is cortical mapping?

What are the anesthetic requirements for the first stage craniotomy?

Based on the results the invasive EEG monitoring conducted after subdural grid placement, the epilepsy multidisciplinary team concluded that an awake craniotomy with intraoperative direct brain stimulation mapping for language was the most appropriate option to allow for epileptogenic foci excision without postoperative speech deficit.

What are the anesthetic considerations for resection of epileptogenic brain region under general anesthesia?

Discuss proconvulsant and anticonvulsant properties of anesthetics

Describe the implications of anesthetic drugs on intraoperative electrocorticography.

What are the risks of awake craniotomy?

Describe preoperative assessment and preparation.

The patient was anesthetized using an asleep-awake-asleep technique. Laryngeal mask airway was used for skin incision and removal of the cranial flap, as well as for dural and skin closures. Dexmedetomidine was the primary anesthetic during the awake portion of the procedure.

What are the anesthetic choices for the awake craniotomy?

What are advantages and disadvantages of dexmedetomidine?

What monitors would you use for this case?

How you position this patient?

The neuropsychologist and surgeon performed the functional testing and seizure focus resection over next 140 minutes. After two hours of being awake, however, the patient begun complaining of headache and become restless.

What are the options in treating intraoperative headache?

What can cause restlessness?

What are the potential complications of the awake craniotomy?
The patient was re-anesthetized with propofol. LMA was reinserted while the patient was in lateral position. The surgery proceeded to closure.

What are your concerns in the immediate postoperative period?

What are the complications of epilepsy surgery?

What is prognosis for the patient after surgical resection of the seizure focus?

PROBLEM BASED LEARNING DISCUSSION

Definition.
A seizure is a brief, excessive surge of electrical activity in the brain that causes a temporary impairment of normal brain function. Epilepsy is a disorder in which a person has two or more seizures without clear cause, such as drug withdrawal, or fever.

Classification of seizures

The seizures are typically classified as generalized or partial. Partial seizures are confined to a localized part of the brain. The simple partial seizure implies no alteration in consiousness. When seizures spread into multiple regions of the brain and alter consciousnes, they are classified as complex partial seizures. The classic generalized seizure implies simultaneous involvement of both cerebral hemisheres. They are subdivided into two major categories: inhibitory (atonic, absence) and excitotary (tonic, clonic, myoclonic).

Incidence.
Of the approximately 2 million American with a diagnosis of epilepsy who are treated with antiepileptic drugs, 20 percent continue to have seizures. This group of patients accounts for over 75 percent of the cost of epilepsy in the United States. For many of those with medically refractory epilepsy, their disability can be completely eliminated by surgical intervention. Only a small percentage of potential surgical candidates, however, are currently referred to epilepsy-surgery centers (1).

Surgical treatment of epilepsy.
Antiepileptic drugs (AED) adequately control about three-quarters of all those who have recurrent seizures. When seizures cannot be controlled by medications or control can be achieved only at the cost of severe and unacceptable adverse effects, surgery is an alternative. The part of the brain where the seizure begins is considered abnormal, so refractory seizures can be cured by surgically removing this abnormal area of the brain. The most common surgical procedures include: 1. Partial or complete temoral lobectomy; 2. Partial frontal lobectomy; 3. Partial parietal and occipital lobectomy. 4. Corpus callosotomy; 5. Hemispherectomy; 6. Multiple subpial transactions; and 7. Placement of the vagus nerve stimulator.

Recent randomized, controlled trial comparing medical and surgical treatment of temporal-lobe epilepsy showed that only 5% of patients completely remitted with medical treatment, while after surgery 65% were completely seizure free (2).

Pre-surgical work-up.
The goal of the pre-surgical work-up is to determine where in the brain the seizures are originating from and whether it can be safely removed. The noninvasive studies such as MRI, PET scans, SPECT are commonly used to localize seizure location. The video-EEG recording, however, is the most important test to define a surgical target, and to map brain function. Placing the electrodes directly on or in the brain (i.e. subdural or depth electrodes) may be necessary to improve precision in localizing epileptogenic foci. The intracarotid sodium amobarbital injections (Wada test) are used to study language and memory function in each hemisphere.

Preoperative clinical evaluation should include review of patient's medication history. Patients are often chronically receiving AEDs with resultant side effects (e.g. gingival hyperplasia with phenytoin, thrombocytopenia with valproic acid, hepatic enzyme elevetaion with carbamazepine). The patients are often left without AEDs for diagnostic purposes. Thus, familiarity with seizure presentation is important in order to recognize perioperative seizure.

Anesthesia for diagnostic procedures.
Propofol infusion is commonly used for sedation of children undergoing neuroradiologic procedures in our institution. No other drugs are usually needed. Children who take AEDs may require higher doses of propofol.

General anesthesia is used for placement of epidural electrodes through multiple burr holes or implantation of subdural grid. The later procedure requires a full craniotomy. As with most cranial procedures, significant hemodynamic fluctuation may occur at various phases of the procedure. Thus, an arterial line is recommended. The patient should be sufficiently awake at the end of surgery so that a neurological examination can be conducted reliably.

General anesthesia for resection of epileptogenic structures.
General anesthesia is used for resection of well delineated epileptogenic foci that is not located in the eloquent areas of the brain (e.g. outside of speech or motor cortex). The choice of anesthesia depends on the need for intraoperative electrocorticography (EcoG). If neither EcoG or cortical mapping is contemplated, the patient's usual AEDs are administered prior to surgery and the anesthetic regimen is designed to maintain suppression of seizure activity and provide optimal operating condition. Any anesthetic technique appropriate for intracranial procedures can be used.

If general anesthesia is used with EcoG, our maintenance anesthetic generally consists of nitrous oxide, propofol and opioid infusions. All inhalational agents affect cerebral electrical activity in a dose dependent manner. If cortical motor area stimulation is necessary, an anesthetic is conducted without the use of neuromuscular blockade. A BIS monitor is recommended in this case to maintain the appropriate depth of anesthesia.

Conscious sedation for awake craniotomy.
Intraoperative cortical stimulation and mapping is the optimal approach for patients with a pathology located near the motor or language areas. Anesthesia for awake craniotomy in adults has varied from local to general with intraoperative awakening during language mapping and seizure foci resection (3). There is limited experience with the anesthetic care of children undergoing awake procedures. Tobias described anesthetic managemet of a 12 year-old boy that included conscious sedation with a propofol infusion plus local anesthetic infiltration of the scalp and dura (4). An asleep-awake-asleep anesthetic technique is used in our institution. Sedation and analgesia during the awake portion of the procedure is maintained with a low-dose dexmedetomidine infusion (5, 6). Dexmedetomidine is a highly specific alpha-2 adrenoreceptor agonist with sedative, analgesic, and anesthetic-sparing effects.

Emergence and postoperative management.
Preoperative tapering of AEDs may increase a risk of postoperative seizures. When a seizure occurs, adequacy of oxygenation and ventilation must be assured. If necessary, the airway is

secured with the LMA or by endotracheal intubation. The seizure may be stopped with a small dose of thiopental (2 mg/kg), midazolam (2-5 mg), or propofol (2 mg/kg). Acute hypertension occurs frequently after intracranial procedures and may predispose to the development of an intracranial hemorrage (7). Labetalol, a combined beta- and alpha-adrenergic antagonist, is often used in our institution. Postoperative hypertension is rarely a problem in patients treated with dexmedetomidine intraoperatively.

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